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(54) SURGICAL THREAD

(71) I, TAICHIRO AKIYAMA, a Japanese subject, of 5–8, Shimoochiai, 3-chome, Shin-juku-ku, Tokyo, Japan, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a surgical thread for use as a ligature or as a sewing or stitching thread.

Threads or filaments of synthetic resin have been widely used as surgical threads, as ligatures or as sewing or stitching threads. The friction of the surface of such a conventional thread is little. Accordingly, for example, when a blood vessel is ligated with the conventional thread, the knot is apt to looosen and the ligating condition is unstable. In order to obtain a stable ligating condition, a double knot or complicated knot of the conventional thread should be made. That is very troublesome. Even in a double knot, the conventional thread has the disadvantage that the thread ligating the blood vessel is apt to slide in the lengthwise direction of the blood vessel.

In order to overcome the above-described disadvantages of the conventional surgical thread, an improved surgical thread was proposed by the present applicant, this thread comprising a thread-like body with a plurality of projections formed at intervals therealong. By using such a surgical thread, the ligating operation of a blood vessel and the stitching operation of incised tissue can be surely and simply effected without making a double knot or a complicated knot.

However, when the blood vessel to be ligated is positioned inside of the incised human body, the bood vessel needs to be drawn outwardly from the inside of the incised human body by a special device such as a forceps. Such operation is still troublesome.

According to the present invention there is provided a surgical thread having a thread-like body with a plurality of projections formed at intervals therealong, and being provided with a needle at one end of the thread-like body, and an eye member at the other end of the thread-like body, the needle, thread-like body and projections being insertable through the eye to form a loop round an object, whereafter the loop man be maintained, and the object held thereby, by reason of projections engaging and being restrained by the edges of the eye.

While retaining good resistance against slipping, the thread of this invention allows a ligating operation of a blood vessel or a stitching operation of incised tissue to be surely and simply effected. Also, a blood vessel positioned inside the incised human body can be surely and simply ligated without being drawn out from the inside of the incised human body.

The present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Fig. 1 is a plan view of a surgical thread according to one embodiment of this invention,

Fig. 2 is an enlarged cross-sectional view of a part of the thread, taken along the line II—II of Fig. 1;

Fig. 3 is a plan view of a mold used for manufacturing the thread-like body of the thread of Fig. 1;

Fig. 4 is a cross-sectional view of the mold, taken along the line IV—IV of Fig. 3;

Fig. 5 is a cross-sectional view of the mold, taken along the line V—V of Fig. 3;

Fig. 6 is a cross-sectional view of the mold and the thread-like body being formed, similar to Fig. 5;

Fig. 7 is a partly cross-sectional view of another mold used for manufacturing the thread-like body of the thread of Fig. 1;

Fig. 8 is a cross-sectional view showing the situation where the hooked needle of the surgcial thread is thrust around a blood vessel inside a human body;

Fig. 9 to Fig. 12 are partly cross-sectional views of the sequential steps of the ligating operation, following the step of Fig. 8, using the surgical thread of Fig. 1;

Fig. 13 is an enlarged perspective view of Fig. 12;

Fig. 14 to Fig. 19 are part cross-sectional views or elevational views of surgical threads

according to further embodiments of this invention.

A ligature for stopping bleeding, being a surgical thread according to one embodiment of this invention, will be described with reference to Fig. 1 to Fig. 13.

Referring to Fig. 1 and Fig. 2, a ligature 21 includes a thread-like body 22 and spherical projections 23 which are formed on the thread-like body 22 at regular intervals. In the ligature 21, a hooked needle 24 is fixed to one end of the body 22, and an eye member 25 providing a round eye 26 is formed at the other end of the body 22.

The body 22 and the spherical projections 23 are formed of synthetic resin such as polyvinyl-alcohol. The length of the body 22 is about 80 cm. The diameter ϕ of the body 22 is 0.3—0.5 mm. For example, it is 0.4 mm. The width W of the projections 23 is 1—1.5 mm. For example, it is 1.2 mm. The distance L between the adjacent projections 23 is 1—1.5 mm. For example, it is 1.2 mm. The spherical projections 23 are formed at regular intervals in the body 22.

Next, a method for manufacturing the thread-like body 22 will be described with reference to Fig. 3 to Fig. 6.

A mold 4 is used in the method. Hemi-spherical recesses 5 are made at regular intervals of, for example, 1.2 mm in a row, in the surface of the mold 4. The diameter of the hemi-spherical recesses 5 is for example, 1.2 mm, corresponding to the shape of the spherical projections 23. Semi-cylindrical grooves 6 are made between the adjacent hemi-spherical recesses 5. The former communicate with the latter. The diameter of the semi-cylindrical grooves 6 is for example 0.4 mm, corresponding to the shape of the body 22.

As shown in Fig. 6, the body 22 formed of synthetic resin such as polyvinyl-alcohol, which has substantially the same diameter as the grooves 6, is fitted into the grooves 6, at a predetermined tension. The lower half of the body 22 is within the grooves 6, while the upper half of the body 22 projects from the upper surface of the mold 4. Spaces which are semi-annular in cross-section, are formed between the body 22 and the inner walls of the hemi-spherical recesses 5.

Next, liquid 8 of synthetic resin such as polyvinyl-alcohol is poured into the above described spaces. Portions of the body 22 in register with the spaces are covered with liquid 8 of synthetic resin, and generally hemi-spherical swellings 9 are thus formed of each of the recesses 5 due to the surface tension phenomenon of the liquid 8, these together comprising spherical projections.

Next, the liquid 8 of synthetic resin is gradually cooled to solidify. As the result, the synthetic resin 8 firmly adheres to the body 22 of synthetic resin. The so produced thread-like body is taken out from the mold 4 by pulling upwardly one end of the body 22. The swelling 9 may be rough which has the effect that the ligature 21 which is tied to the blood vessel is harder to slip along the blood vessel, as described below.

The hooked needle 24 is fixed to an end of the body 22 by a suitable method. It may be fixed to the end of the body 22 by the liquid synthetic resin used in the mold operation to form the projections 23. The eye member 25 may be formed integrally with the other end of the body 22 at the same time as the projections 23 are formed using the mold 4 shown in Fig. 3. In that case, an annular recess (not shown) is formed in the mold 4, contiguous to the end groove 6.

The diameter of the eye 26 of the eye member 25 is larger than the diameters of the needle 24 and the body 22, and is slightly larger than that of the projections 23. In the ligating operation, the hooked needle 24, the body 22 and the projections 23 can pass through the eye 26 of the eye member 25 to form a loop round a blood vessel. The spherical projections 23 may be rough.

Next, another method for manufacturing the thread 21 will be described with reference to Fig. 7.

A pair of mold rolls 12 and 13, facing each other, is arranged in a mold apparatus 14 used for this method. Hemi-spherical recesses 15 and arched grooves 16 are formed in the circumferences of the mold rolls 12 and 13, corresponding to the shape of the thread body with projections 21. The mold 4 shown in Fig. 3 may be curved into the roll 12 or 13. The rolls 12 and 13 are rotated at a predetermined speed in opposite directions, as shown by the arrows 17 and 18 on Fig. 7. The body 22 of synthetic resin such as polyvinyl-alcohol is vertically moved through the nip 19 between the rolls 12 and 13, in the direction shown by the arrow 20 on Fig. 7, while the liquid of synthetic resin such as polyvinyl-alcohol is poured into the recesses 15 from above the nip 19. The body 22 is nipped at the nip 19 between the rolls 12 and 13 to be pressed to the recesses 15 filled with the liquid of synthetic resin. The liquid is cooled to a predetermined solidification temperature at the nip 19 or directly under the nip 19. Thus, the spherical projections 23 are formed at regular intervals of e.g. 1.2 mm in the body 22 having the diameter of e.g. 0.4 mm, which is taken out from the rolls 12 and 13. Then, the hooked needle 24 and the eye member 25 are formed on the respective ends of the thread 22, as described above. Of course, the produced thread 21 has the same effect as the thread 21 produced by the mold 4 shown on Fig. 3, and a blood vessel can be ligated by it, as below mentioned. This method is more suit-

able for the mass production of the thread 21.

Next, a method for ligating the blood vessel with the thread 21 will be described with reference to Fig. 8 to Fig. 13.

In a surgical operation, a part of the human body 33 or the tissue is incised. The bood vessel 34 is exposed or embedded in the tissue or positioned inside the human body 33. By using the thread 21, the blood vessel 34 need not be drawn out from the inside of the human body 33 or from the tissue with the hand or a device. First, the hooked needle 24 of the thread 21 is stuck into the tissure 33 round the blood vessel 34, and it is rotated round the blood vessel 34 by about 180 degrees. As shown by the dot-dash line on Fig. 8, the hooked needle 24 is taken out from the tissue 33, and so the blood vessel 34 is perfectly caught.

The hooked needle 24 is further drawn outwardly, and the tip of the hooked needle is inserted through the eye 26 of the eye member 25. The human body or tissure 33 is not shown in Fig. 9 to Fig. 13. Only the blood vessel 34 is shown.

After the hooked needle 24 is inserted through the eye 26 of the eye member 25, the hooked needle 24 is pulled up in the direction shown by the arrow 35 on Fig. 10, with one hand, while the eye member 25 is pushed down toward the blood vessel 34 in the direction shown by the arrow 36 on Fig. 10, with another hand. The body 22 and the projections 23 pass through the eye 26 of the eye member 25 to form a loop 37 round the blood vessel 34. The size of the loop 37 is reduced with the pulling-up of the hooked needle 24. Finally, the eye member 25 contacts with the blood vessel 34, and the ligature 21 is wound on the blood vessel 34, as shown in Fig. 11.

Further, the eye member 25 is pushed down to squash the blood vessel 34, as shown in Fig. 12. In that condition, the ligature 21 cannot be pulled up further. Thus, the ligature 21 is tightly wound on the blood vessel 34 to ligate the latter.

In the ligating condition shown in Fig. 12 as apparent from Fig. 13, the one projection 23, which has just passed through the hole 26, contacts tightly with the edge of the eye remote from the blood vessel, while the adjacent other projection 23, which has not yet passed through the hole 26, contacts tightly with the edge of the eye near the blood vessel. Due to the frictional forces between these edges and projections 23, and between the projections and the blood vessel 34, the ligature 21 is securely tied round the blood vessel 34, although the hooked needle 24 and the eye member 25 are separated from the hands of the operator. The shape of the eye member 25, and therefore of the eye 26 is slightly changed according to the shape of the blood vessel 34. It is more difficult for the projection 23 to pass through the deformed hole 26. Accordingly, the ligature 21 is more securely tied round the blood vessel 34. Moreover, since frictional forces occur between the projections 23 and the blood vessel 34, the ligature 21 cannot slide along the circumference of the blood vessel 34 and in the lengthwise direction of the blood vessel 34.

The ligature 21 is cut off at the desired position by a cutting apparatus. The bleeding is stopped by the ligature 21 wound tightly round the blood vessel 34. The ligating operation is more sure and simple than by the conventional method.

Fig. 14 and Fig. 15 show a further embodiment which differs from the embodiment of Fig. 1 only in the shapes of the projections. The parts in this embodiment which correspond to the parts in the embodiment of Fig. 1, are denoted by the same reference numerals, which will not be described in detail.

In this embodiment, cone-shaped projections 63 are formed at regular intervals in the body 22. Surfaces 63*a* of the cone-shaped projections 63 taper in the pulling direction shown by the arrow 35 in Fig. 14, of the ligature 21, and they are elastic. Accordingly, the cone-shaped projections 63 yield to the eye 26 of the eye member 25 and can smmothly pass through the eye 26 of the eye member 25 although the bottom diameter of the cone-shaped projections 63 is slightly larger than the diameter of the eye member 25, as shown in Fig. 14 and Fig. 15. After passing through the eye 26, the cone-shaped projection 63 is restored to its original shape, as shown in Fig. 15. Accordingly, it cannot pass through the eye 26 in the direction opposite to the direction shown by the arrow 35 in Fig. 15. Since the ligature 21 is prevented from moving in the direction opposite to the direction shown by the arrow 35, the ligature 21 ligating the blood vessel is prevented from loosening.

Fig. 16 shows a ligature according to a still further embodiment of this invention. This embodiment is different from the embodiment of Fig. 1 in the construction of the eye member. In this embodiment, the eye member is constructed in such a manner that the end portion of the body 22 is double-knotted to form a round hole 66. The method for ligating the blood vessel with the ligature 21 of Fig. 16 is the same as with the ligature 21 of Fig. 1.

Fig. 17 and Fig. 18 show a ligature according to a still further embodiment of this invention. This embodiment is also different from the embodiment of Fig. 1 in the construction of the eye member. In this embodiment, the eye member 25 of the ligature 21 of Fig. 1 is dipped into liquid polyvinyl-

alcohol to form a disk-like film 65 covering the eye 66. In the ligating operation, the blood vessel is caught by the ligature 21, as shown on Fig. 8, and then the film 65 is pierced nearly at the centre with the tip of the hooked needle 24, as shown in Fig. 18. Since the film 65 of polyvinyl-alcohol is thin, the hooked needle 24 and the projections 23 can easily pass through the eye member 65 comprising the film. Thereafter, the blood vessel can be ligated with the ligature 21 in the same manner as in the method described above for the ligature 21 of Fig. 1. The shape of the hole 66 is almost unchanged both when the ligature 21 is not in use, and when it is in use.

Fig. 19 shows a ligature according to a still further embodiment of this invention. This embodiment is different from the embodiment of Fig. 1 only in the shape of the projections. In this embodiment, bowl-like projects 83 having a hemi-spherical space 80 are formed at regular intervals on the body 22. Since the projections 83 are elastic, they yield to the shape of the eye 26 of the eye member 25, and can pass easily through the eye 26, as shown in Fig. 19. After passing through the eye 26, the projections 83 are restored to their original shape, as shown by the dot-dash line in Fig. 19. Accordingly, the ligature 21 cannot be pulled in the direction opposite to the direction shown by the arrow 35 on Fig. 19.

Although illustrative embodiments of this invention have been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein. For example, the shape of the projections may be unsymmetrical with respect to the lengthwise direction of the thread. The projections may be formed at irregular intervals in the thread. The thread and the projections may be formed at the same time in such a manner that the liquid synthetic resin is poured both into the recesses 5 and into the grooves 6, in the mold 4 of Fig. 3.

The surgical thread in accordance with this invention can be used not only as a ligature, but also as a stitching thread or suture.

WHAT I CLAIM IS:—

1. A surgical thread having a thread-like body with a plurality of projections formed at intervals therealong, and being provided with a needle at one end of the thread-like body, and an eye member at the other end of the thread-like body, the needle, thread-like body and projections being insertable through the eye to form a loop round an object, whereafter the loop may be maintained, and the object held thereby, by reason of projections engaging and being restrained by the edges of the eye.

2. A surgical thread according to claim 1, in which said thread-like body and said projections are formed of synthetic resin.

3. A surgical thread according to claim 2, in which said synthetic resin is polyvinyl-alcohol.

4. A surgical thread according to claim 1, 2 or 3, in which said projections are spherical.

5. A surgical thread according to claim 1, 2 or 3 in which said projections are cone-shaped, the surfaces of said projections tapering towards the end of the thread-like body at which the needle is attached.

6. A surgical thread according to claim 1, 2 or 3, in which said projections are bowl shaped, the surfaces of said projections tapering towards the end of the thread-like body at which the needle is attached.

7. A surgical thread according to any one of claims 1 to 6 in which said needle is hooked.

8. A surgical thread according to any one of claims 1 to 7 in which said eye is defined by a ring.

9. A surgical thread according to any one of claims 1 to 8, in which said eye is formed integrally with said thread-like body.

10. A surgical thread according to claim 9, in which said eye is covered with a film of synthetic resin.

11. A surgical thread substantially as hereinbefore described with reference to and as shown by Figures 1, 2 and 8 to 13 of the accompanying drawings.

12. A surgical thread substantially as hereinbefore described with reference to and as shown in Figures 14 and 15 of the accompanying drawings.

13. A surgical thread substantially as hereinbefore described with reference to and as shown by Figures 16, 17 or 18 of the accompanying drawings.

14. A surgical thread substantially as hereinbefore described with reference to and as shown by Figure 19 of the accompanying drawings.

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FIG.1

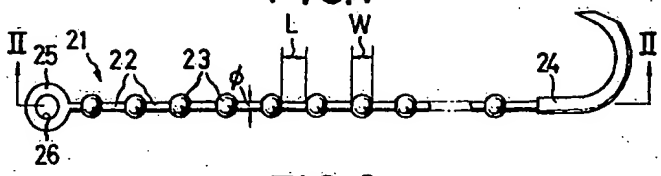

FIG.2

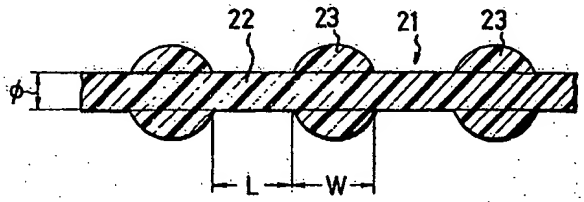

FIG.3

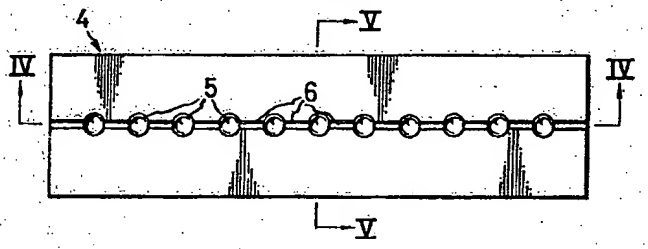

FIG.4

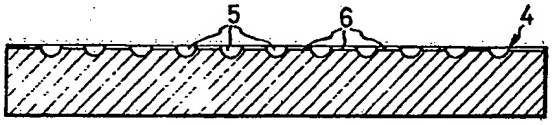

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FIG.5

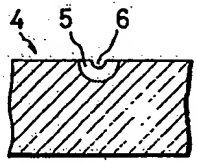

FIG.6

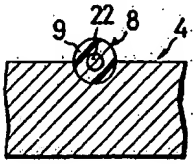

FIG.7

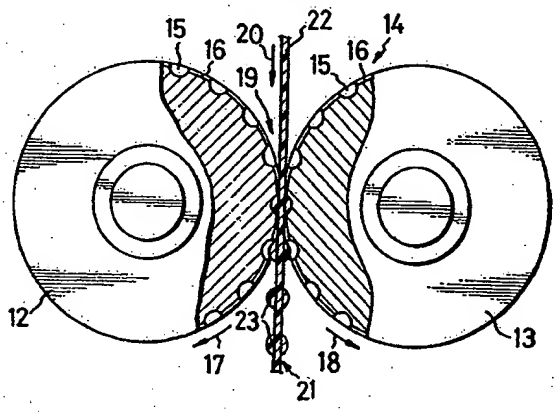

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FIG.10

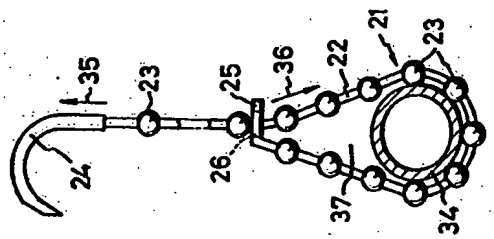


FIG.9

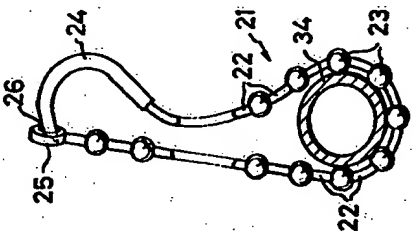
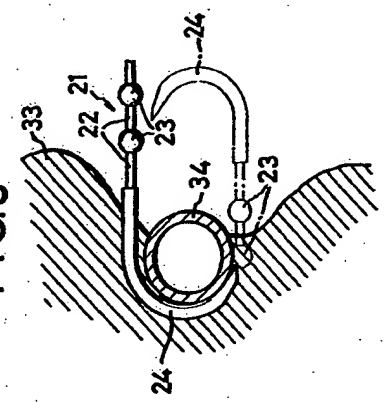


FIG.8



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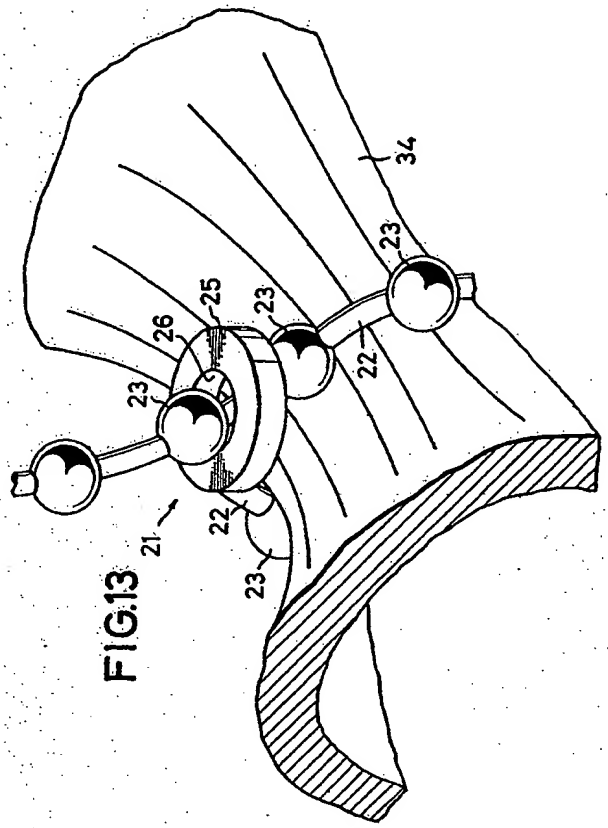

FIG.13

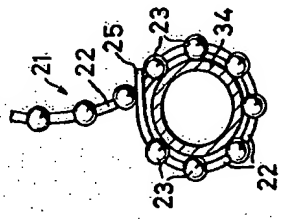

FIG.11

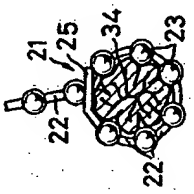

FIG.12

FIG.14

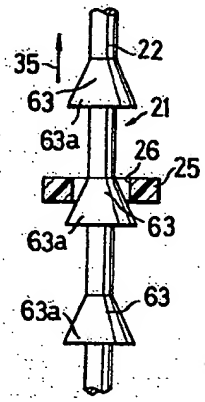

FIG.15

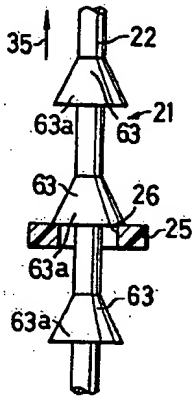

FIG. 19

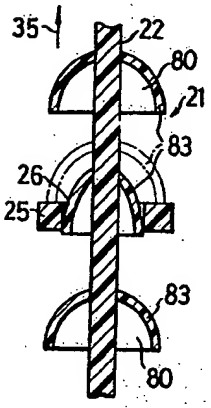

FIG.16

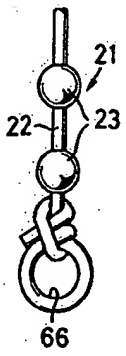

FIG.17

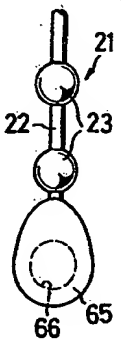

FIG. 18